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## □ The Anthropocene in the Solar System

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### Observing the anthropocene

Perspectives and data derived from satellites in Earth orbit have been integral to the very apprehension of what is now being called the “anthropocene.” The launch of Sputnik 1 by the USSR in 1957, as part of the scientific programme of the International Geophysical Year (IGY), enabled the first observation of Earth from outside the atmosphere. The data from the early generation of satellites was thus the first ever collected at a global scale, capturing the whole Earth.

During the IGY, more than 20,000 scientists from 67 nations studied solar activity, cosmic rays, geomagnetism, ocean currents and polar ice (Odishaw 1958). As well as new technologies for collecting data in the form of satellites, this monumental effort of international cooperation was supported by computers that could process increasingly large quantities of data in a way never possible before (Lovbrand *et al.* 2009).

In the 1960s, the Apollo era of lunar exploration, images of the whole Earth (first taken by the Apollo 8 mission in 1968) contributed to a growing consciousness of the Earth as a fragile ecosystem surrounded by unforgiving space. James Lovelock was heavily influenced by the Apollo 8 images of the whole Earth and Earth observation data in his formulation of the Gaia hypothesis (Clark 2005, 167). Lovelock’s vision of Earth as a self-regulating feedback system was foundational in the emergence of Earth Systems Science as a discipline (Lovbrand *et al.* 2009).

Earth Systems Science is sustained by satellite data and its analysis; and it is this data which has allowed the measurement of global changes now attributed to anthropogenic effects (Vince 2011, 34). Satellites have been integral to both defining and characterising the anthropocene.

### Spaceship Earth vs ex-orbitant globality

The concept of Earth as a spaceship with limited resources was first popularized in a 1966 book by the influential economic theorist Barbara Ward (1966). In this view, Earth was a hermetically sealed capsule of life: the integration of humans and nature in the Earth system was defined in opposition to the menace of the cold and lifeless space outside. This formulation is still very prevalent in popular understandings; however, it is not the only way to contextualize the Earth. Smolin (1997) argued against the vision of Earth as a living island alone in a dead universe, highlighting the role of stars as the source of light and energy, and the Earth as part of a mobile solar system participating in the greater galactic movement. Clark (2005) pointed to the incursions of Near Earth Objects, solar radiation, meteorites and meteor showers, the electromagnetic phenomena of the northern and southern lights, the tidal effects of the Moon, and the estimated

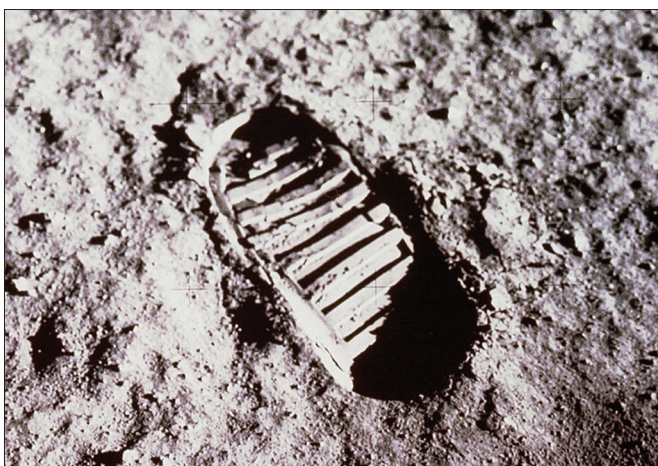
40,000 tons of cosmic dust which falls to Earth each year, as evidence of “earth as an open system in interchange with a dynamic cosmos” (2005, 166). For him, theorizing “ex-orbitant globality” destabilized the conceptual perimeter of the planet and created an opening for events beyond the human realm.

Since the 1960s, research has also dethroned the Newtonian paradigm of the clock-work solar system. Far from being sempiternally stable, its non-linear mechanics indicate a state of unstable equilibrium; erratic and catastrophic movements of celestial bodies have been demonstrated in the past, and predicted for the future (e.g. Milani and Nobili 1992). While the “anthropocene” creates an anxiety that the Earth has been thrust into a state of disequilibrium from which there may be no return, it could be argued this is the “natural” state of the solar system, rather than an aberration.

### **The human footprint in space**

In any case, the boundaries of Spaceship Earth have already been breached by human activities (Figure 1). As well as satellites in Earth orbit, spacecraft orbit the Moon, Sun, Venus, Mars and several other celestial bodies; there are landing sites on the Moon, Mars, Venus, Titan, asteroids, and comets, and four spacecraft in the region of the heliopause, where the solar wind meets interstellar space. The interchange with the cosmos has been far from one-sided.

In this smear of human culture across the 40 astronomical unit span of the solar system, Earth orbit remains the densest in artifacts. According to figures from NASA, there have been more than 4,600 rockets launched since 1957. The fragmentation of these objects, by factors in the space environment, occasional collisions with other bits of space junk, and deliberate destruction, has resulted in more than 21,000 objects that are larger than 10 cm, a general limit of tracking capability (NASA Orbital Debris Program Office 2012). The estimated population of particles between 1 and 10 cm in diameter is approximately 500,000, while those smaller than 1 cm exceed 100 million. Together, this material is estimated to weigh 6,000 tons, equivalent to 1,000 elephants in Earth orbit. Only 6% are operational spacecraft. And the quantity of space junk is constantly increasing.



**FIGURE 1.** The human footprint in space (Image courtesy of NASA).

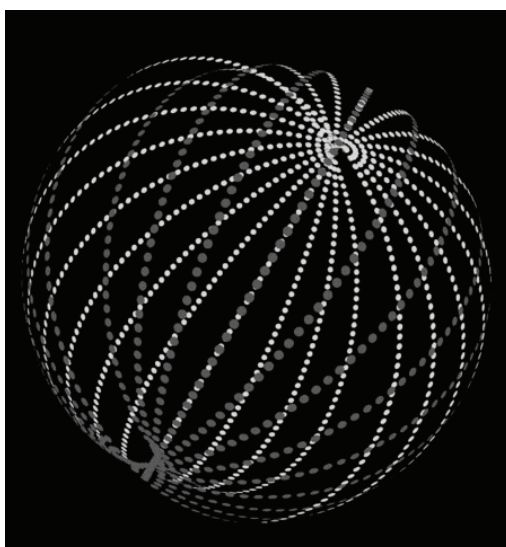
Despite the common perception of space as a vacuum, it is a rich and complex environment. Beyond the atmosphere are high energy cosmic rays emanating from the far reaches of the galaxy, the constant stream of sub-atomic particles that is the solar wind, charged clouds of high temperature gases, swarms of meteors, and atoms of hydrogen, helium and oxygen. The interpolation of spacecraft has added elements, minerals and molecules that are not “naturally” found in interplanetary space. The most common material in spacecraft manufacture is aluminium, the third most abundant element in the Earth’s crust, but absent in the predominantly hydrogen/helium environment of space. Other common materials are titanium, carbon fibre composites, silicon in photovoltaic cells, fuels such as hydrazine, nickel and cadmium used in batteries. If the anthropocene on Earth has involved the redistribution of elements such as carbon and nitrogen, this is also true of the movement of elements from terrestrial environments into space.

As for measuring the extent or impact of such redistribution, at this point in time I can only say that there is “insufficient data for a meaningful answer” (Asimov 1986 [1956]). There are few studies which compare the “natural” space environment to the “cultural” space environment because this is not a question which concerns space scientists. Most satellites focus their gaze either on Earth or far space. Moreover, in order to obtain such data, satellites must be designed to collect it, thus contributing to the very effect they seek to measure in a classic Heisenbergian paradox.

There are more subtle changes too. Satellites are merely the visible component of their core function: the collection and transmission of data in the electromagnetic spectrum. In certain parts of the spectrum, activity has escalated from “quiet” to “noisy” with the proliferation of electronic devices and the increase in satellite telecommunications. Keeping bands of the spectrum clear for scientific and other uses is now a constant battle as spectrum allocation is a critical limit on telecommunications. Again, available data is rarely geared towards assessing the contribution of human activity to the overall electromagnetic character of the solar system. Reflectance spectroscopy in the visible wavelengths has been used to determine that older satellites reflect less blue light due to their rougher, more weathered surfaces (Bédard *et al.* 2010), but this has not been compared to non-human space objects. The rest of the spectrum is regarded as an economic resource.

### Extreme anthropocene

In contrast to the anxiety-inducing terrestrial anthropocene, Clark’s notion of “ex-orbitant globality” (2005) creates a positive “space” for new structures, processes, and potentialities. At their most extreme, these might include Dyson spheres and Matrioshka brains. Dyson spheres are planet-scaled shells used to capture a star’s entire energy output for the planets enclosed within it, hypothetically necessary to fuel the growth of a space-industrial civilization (Dyson 1960). Matrioshka brains are computing devices arranged in concentric Dyson shells which encompass entire planetary systems (Bradbury 1997–2000). To build such megastructures, whole planets may be dismantled and cannibalized. Far-fetched this may seem; but there is a reasonable amount of theorizing around such structures, as their detection in this or other galaxies can be taken as evidence of other technological sentient life. Indeed, our own anthropogenic signatures are the very things that might alert such a “civilization” to this “utterly insignificant little blue-green planet” (Adams 2002, 5).



**FIGURE 2.** A Dyson swarm (Image courtesy of Wikimedia Commons)

A variant of physicist Freeman Dyson's concept is a spherical constellation of solar-orbiting satellites (Figure 2). The assemblage of space junk currently orbiting Earth may be a precursor of such a structure, incohesive and ramshackle, but to the outside observer equivalent perhaps to the Berekhat Ram figurine or an East Anglian eolith: evocative in its similarities, but barely recognisable as a cultural object.

The extension of signals in human-preferred bands such as Ka (26.5–40 GHz) throughout the solar system, but especially in Earth orbit, could be likened to the early stages of Teilhard de Chardin's noosphere (1959), emerging through the interaction of human minds via the medium of Earth observation and telecommunication satellites. Taken to its logical conclusion, Teilhard de Chardin's schema of human evolution approximates the Matrioshka brain as the hardware needed to support human thought is increasingly sustained outside the body.

The anthropocene cannot be understood without reference to space. The Sun, Moon, and electromagnetic environment shape and drive the climate of the Earth. Clark (2005) reminds us that terrestrial processes are inevitably intertwined with the extraterrestrial, and that by breaking the confines of spaceship Earth and allowing space in, we open up an "ex-orbitant" excess in place of perceived limits. Others have been predicting a new paradigm linking Earth and space sciences, a trajectory initiated by the IGY (Davis 1996). With the development of terrestrial space industry, there is now a constant two-way traffic between Earth and space; and their separation no longer provides useful parameters for understanding the impacts of global industry (Gorman 2009).

An archaeological perspective transfigures space into a new entity incorporating elements, minerals, materials and wavelengths created by human activities, which are not separate and removable from an inert Cartesian substrate, but now part of its essence. The terraforming of Earth is the first human act of planetary-scale engineering, despite its unintentional nature. By sending little chunks of Earth matter into space, we are also changing the very fabric of near space by the merest chemical fraction, as the earliest

Archaean photosynthesizing bacteria did 3.5 million years ago. The anthropocene is more than just a new geological era: the archaeologist's lens reveals it to be a cosmological phenomenon.

## References

- Adams, D. 2002 [1979]. *The Ultimate Hitchhiker's Guide to the Galaxy*. New York: Ballantine Books.
- Asimov, I. 1986 [1956]. "The Last Question" in *Robot Dreams*, by I. Asimov, 234–246. New York: Berkley Publishing Group.
- Bédard, D. G., A. Wade, D. Monin and R. Scott. "Spectrometric Characterization of Geostationary Satellites." Paper presented to the AMOS (Advanced Maui Optical and Space Surveillance Technologies) conference, Hawai'i, 2010. Available online: [www.amostech.com/TechnicalPapers/2012/POSTER/BEDARD.pdf](http://www.amostech.com/TechnicalPapers/2012/POSTER/BEDARD.pdf)
- Bradbury, R. 1997–2000. *Matrioshka Brains*. Available online: [www.gwern.net/docs/1999-bradbury-matrioshkabrain.pdf](http://www.gwern.net/docs/1999-bradbury-matrioshkabrain.pdf), accessed August 1, 2013.
- Clark, N. 2005. "Ex-orbitant Globality." *Theory, Culture and Society* 22(5): 165–185. <http://dx.doi.org/10.1177/0263276405057198>
- Davis, M. 1996. "Cosmic Dancers on History's Stage? The Permanent Revolution in the Earth Sciences." *New Left Review* 217: 48–84.
- Dyson, F. J. 1960. "Search for Artificial Stellar Sources of Infrared Radiation." *Science* 131: 1667–1668.
- Gorman, A. C. 2009. "The Gravity of Archaeology." *Archaeologies: The Journal of the World Archaeological Congress* 5(2): 344–359
- Lovbrand, E., J. Strippel and B. Wiman. 2009. "Earth System Governmentality. Reflections on Science in the Anthropocene." *Global Environmental Change* 19: 7–13.
- Milani, A. and A. Nobili. 1992. "An Example of Stable Chaos in the Solar System." *Nature* 357: 569–571. <http://dx.doi.org/10.1038/357569a0>
- NASA Orbital Debris Program Office. 2012. *Orbital Debris Frequently Asked Questions*. Available online: <http://orbitaldebris.jsc.nasa.gov/faqs.html#3>, accessed August 1, 2013.
- Odishaw, H. 1958. "International Geophysical Year." *Science* 128: 1599–1609.
- Smolin, L. 1997. *The Life of the Cosmos*. London: Weidenfeld and Nicolson.
- Teilhard de Chardin, P. 1959. *The Phenomenon of Man*. New York: Harper and Row.
- Vince, G. 2011. "An Epoch Debate." *Science* 334: 32–37. <http://dx.doi.org/10.1126/science.334.6052.32>
- Ward, B. 1966. *Spaceship Earth*. New York: Columbia University Press.

## ▣ The Anthropocene and Transdisciplinarity

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From the early 2000s, the term "anthropocene" circulated widely in both academic and journalistic circles. By 2008, a group of scientists argued that the anthropocene was a useful concept for denoting the measurable impacts of humanity on the planet. They submitted a proposal to the Stratigraphy Commission of the Geological Society of London, lobbying for an official geological designation (Zalasiewicz *et al.* 2008). The Earth, they argued, had emerged from the Holocene; humanity was now living in the anthropocene.

Scholars from across the disciplines quickly discovered the term to be pliant, popular, and therefore useful for a host of different claims and theoretical constructs. Consequently,